

BELLCOMM, INC.

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WASHINGTON, D. C. 20024

B71 01025

SUBJECT: Apollo 14 Launch Vehicle
Engine-Out Performance
Capability - Case 310

DATE: January 21, 1971

FROM: K. P. Klaasen

MEMORANDUM FOR FILE

Attached are copies of the viewgraphs presented to Dr. R. A. Petrone on January 13, 1971, covering the topic of Apollo 14 launch vehicle performance capability with one or more engines out. Apollo 14 capability data as determined by MSFC were presented and compared to similar data for Apollo 13.

A question was raised during the presentation regarding the assumptions used in determining those engine-out malfunctions that result in "loss of control" of the vehicle. In obtaining the results presented, the effects of all malfunctions were evaluated for an otherwise nominally performing vehicle. For malfunctions where winds have a significant effect, the vehicle was flown in the maximum 95 percentile February/March wind. The gust was phased with the malfunction to establish a worst case. For malfunctions where winds do not have a significant effect, the average 50 percentile February/March wind from 252.067 degrees was used.¹ Vehicle "loss of control" occurs for engine-out malfunctions that result in (1) tower or pad collisions, (2) a thrust-to-weight ratio that is too small to maintain a controlled trajectory, (3) subsequent gimbal angle commands that are too large for the engines to fulfill, (4) manual or automatic abort cues, or (5) structural failure of the vehicle.

During the Apollo 6 (AS-502) flight, the two upper engines of the S-II stage lost thrust about 265 seconds after S-IC/S-II separation. This malfunction occurred at a time close to the borderline between the regions of possible loss of control of the vehicle and earth parking orbit capability. Although the Apollo 6 mission rules called for early staging to the S-IVB for such a malfunction, flight controllers did not fully understand the nature of the failure until the critical period for loss of control had passed. Therefore, the vehicle was allowed to continue its flight and did achieve the desired earth parking orbit successfully. This engine-out failure prompted a thorough re-evaluation of launch vehicle engine-out performance capability, results of which were used in formulating subsequent mission rules.

2013-KPK-jab

K. P. Klaasen
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Attachments

¹MSFC Memorandum, S&E-AERO-MFT-10-71, "AS-509 Saturn V Launch Vehicle Operational Flight Dynamics and Malfunction Flight Analysis," January 12, 1971.



N79-72556

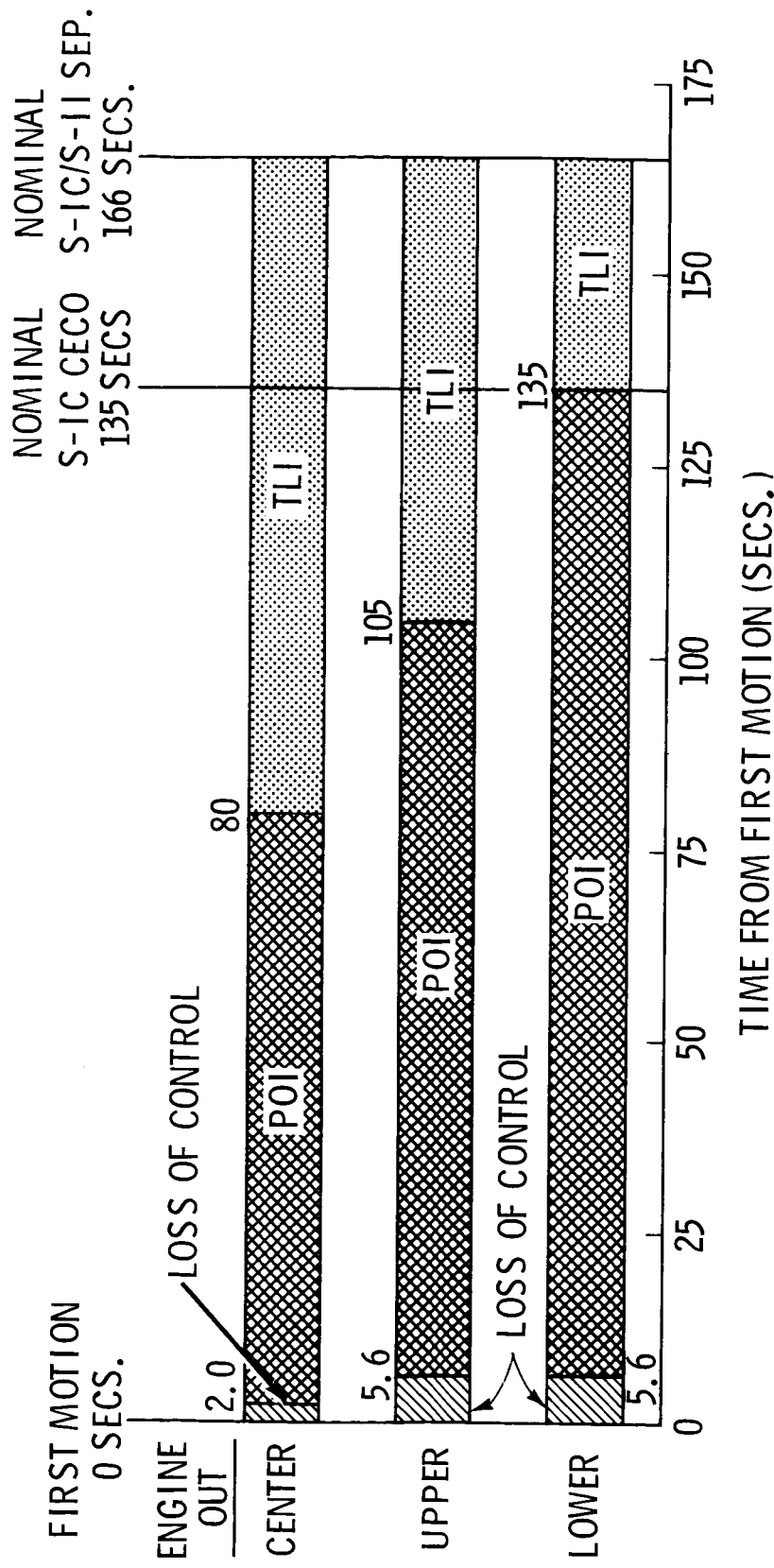
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(NASA-CR-116952) APOLLO 14 LAUNCH VEHICLE
ENGINE-OUT PERFORMANCE CAPABILITY (Bellcomm,
Inc.) 5 p

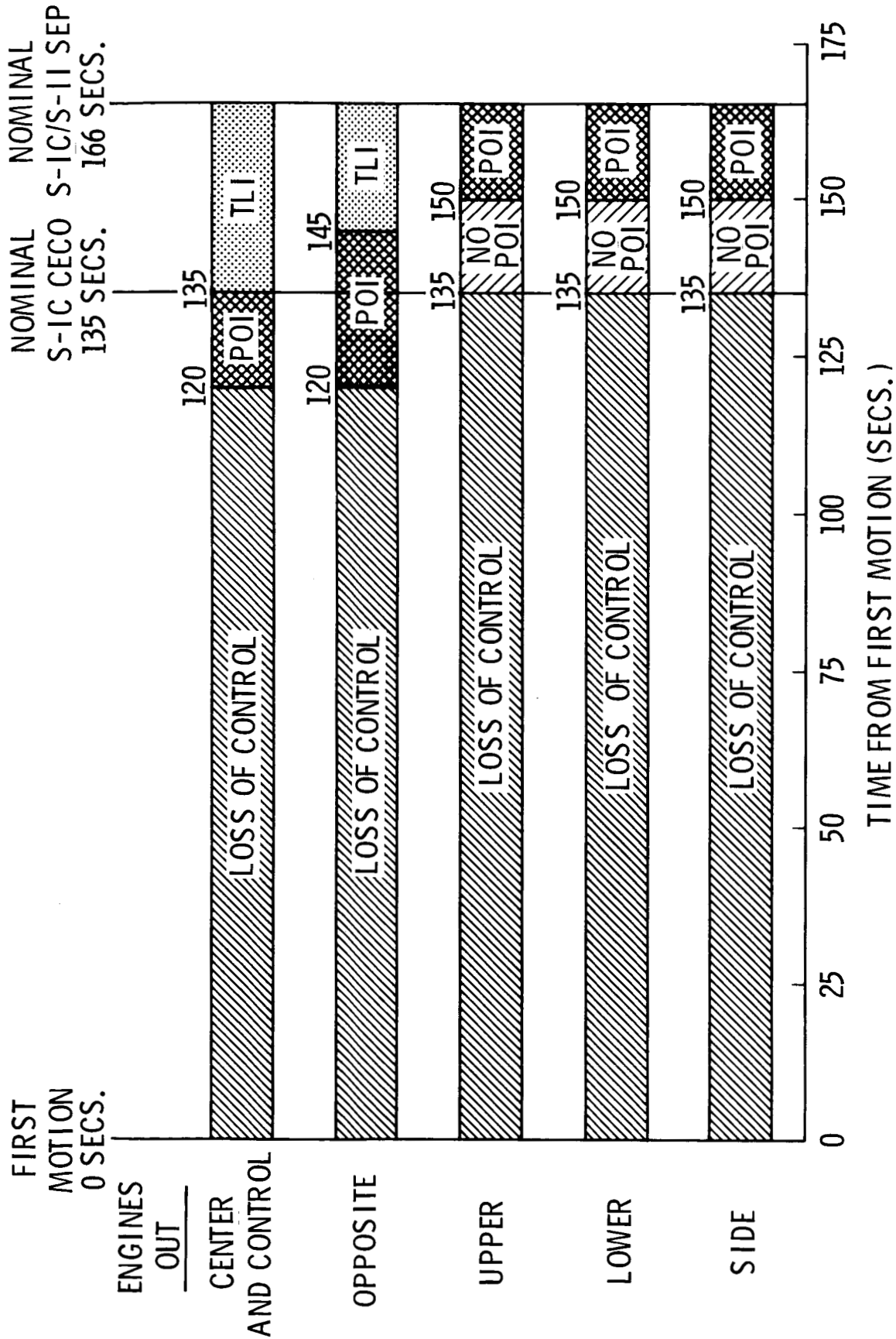
PAGES- 5

NASA CR-116952

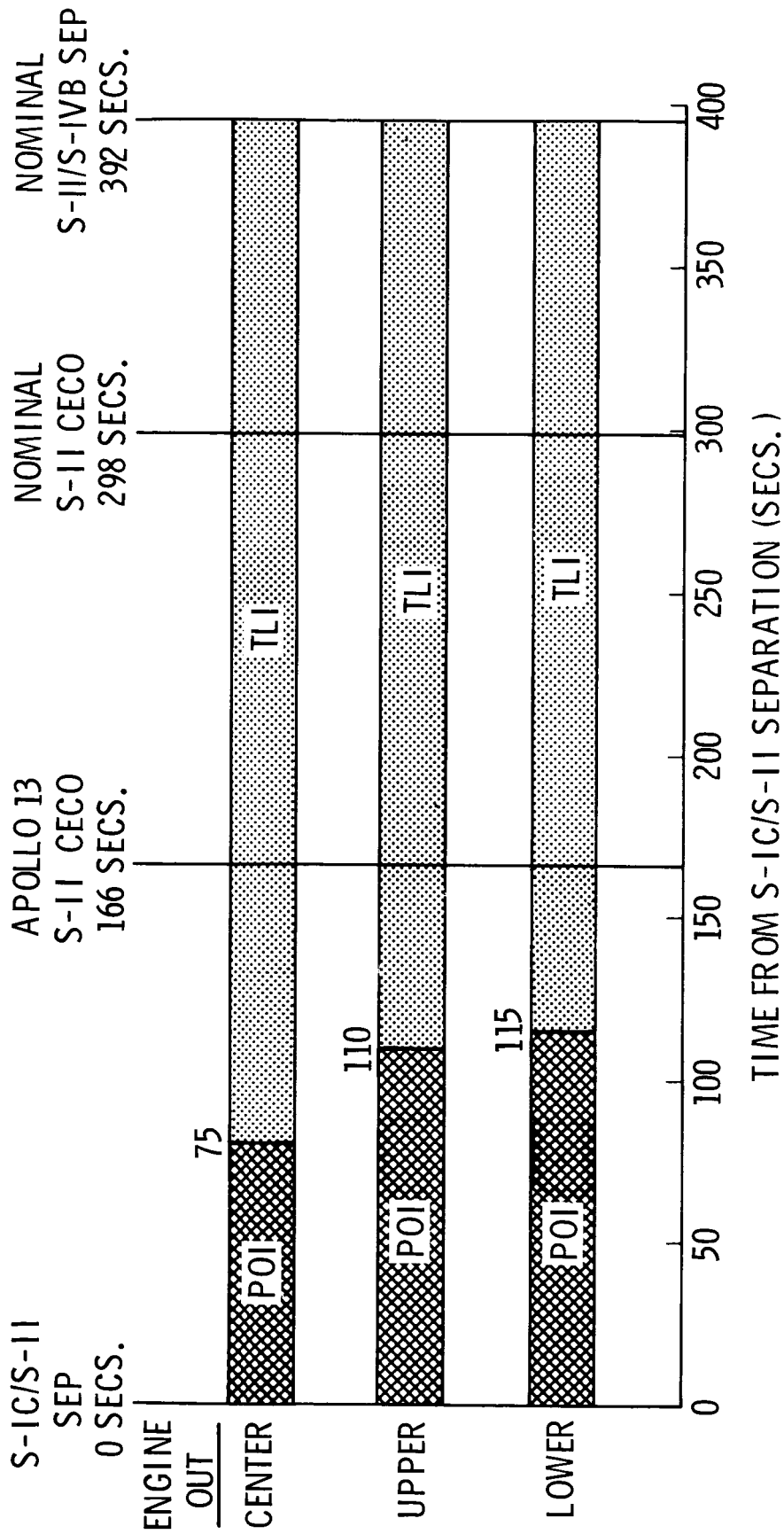
S-1C SINGLE ENGINE OUT CAPABILITY (APOLLO 14)



S-IC DUAL SIMULTANEOUS ENGINE OUT CAPABILITY (APOLLO 14)

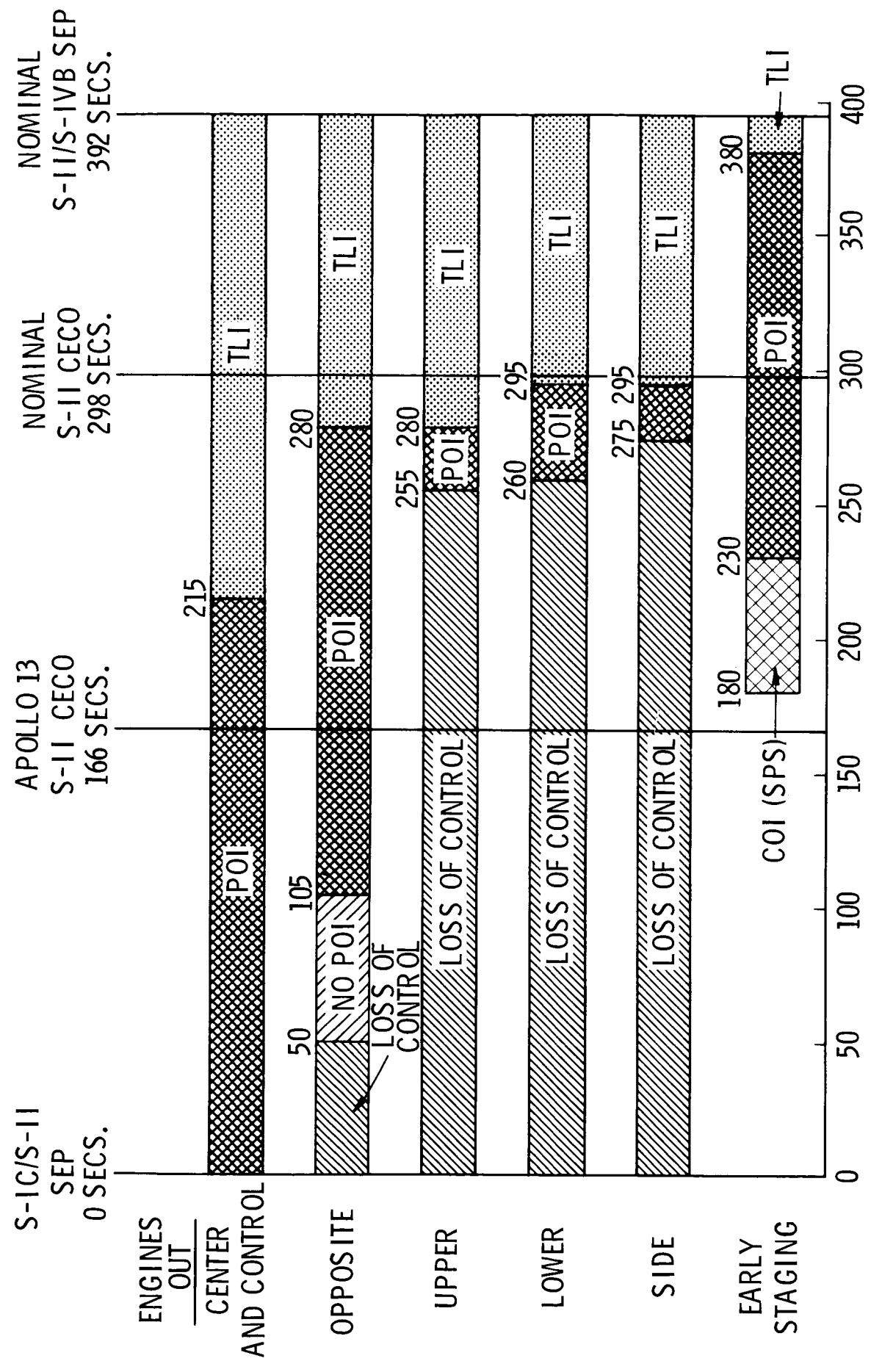


S-II SINGLE ENGINE OUT CAPABILITY (APOLLO 14)





S-II DUAL SIMULTANEOUS ENGINE OUT AND EARLY STAGING CAPABILITY (APOLLO 14)



TIME FROM S-IC/S-II SEPARATION (SECS.)

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